Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

aSB945
.G9G9

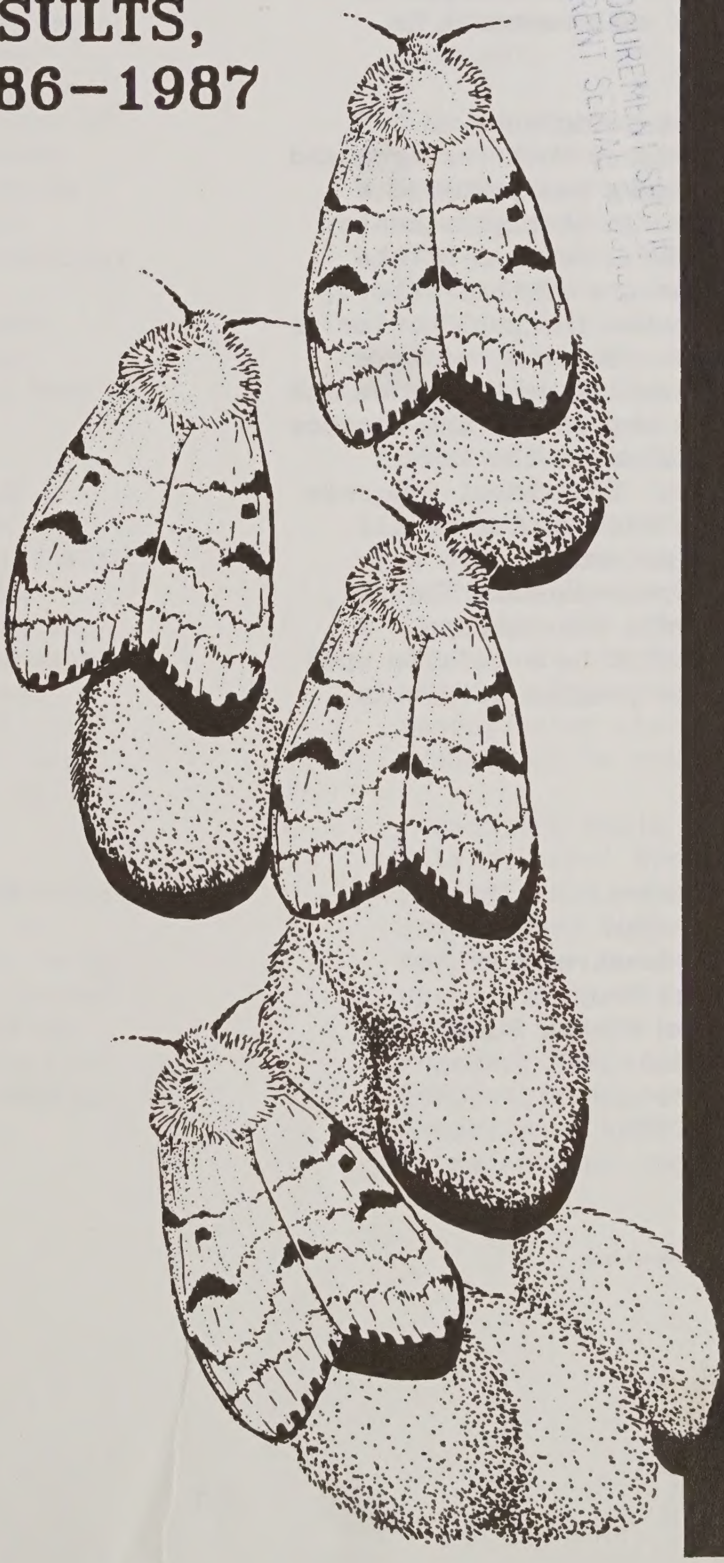
INTERMOUNTAIN RESEARCH STATION
APR 18 1988
STATION LIBRARY COPY

GYPSY MOTH NEWS
370 REED ROAD, BROOMALL, PA 19008
U.S.D.A., FOREST SERVICE

March 1988
Number 16

RESEARCH RESULTS, 1986–1987

PROCUREMENT SECTION
CURRENT SERIAL RECORDS



INTRODUCTION

The last report on gypsy moth research appeared in this newsletter in January 1986 and described accomplishments for the 1985 field season. Although the same level of research continued in 1986, two changes in the leadership of the Gypsy Moth Research and Development Program located at the Northeastern Forest Experiment Station in Broomall, PA, caused a lapse in reporting gypsy moth research in January 1987.

Recognizing this deficiency in reporting, the Gypsy Moth Research and Development Program has prepared a summary of research accomplishments for 1986 and 1987. Because of the comprehensive nature of that report, it was not suitable for publication in Gypsy Moth News. Instead, we have prepared this special condensation and synthesis which represents the essence of results included in the Annual Progress Report. The Annual Progress Report is being distributed to all program investigators, and to key administrators representing Federal, State, and private user groups. A limited supply will be available upon request from the program office in Broomall.

Max W. McFadden
Program Manager
Gypsy Moth Research and
Development Program
Northeastern Forest Station
370 Reed Road
Broomall, PA 19008
(215) 690-3118

GYPSY MOTH RESEARCH UPDATE

1986 AND 1987

The goal of the Gypsy Moth Research and Development Program is to improve the management of low level gypsy moth populations in order to prevent the occurrence of outbreaks or to lessen the impact and frequency of outbreaks. This research goal includes seven research objectives:

1. To determine the effects of gypsy moth on **forests**;
2. To improve the understanding of the biology and population dynamics of **gypsy moth**;
3. To develop the means to utilize **parasites** as regulators in low level gypsy moth populations;
4. To determine the role of invertebrate and vertebrate **predators** in low level gypsy moth populations;
5. To determine the role of selected **pathogens** and develop technology to utilize them as regulators in low to medium gypsy moth populations;
6. To evaluate the role of **integrated pest management** (IPM) for gypsy moth;
7. To develop scientific **technical support** for gypsy moth research.

Twenty-six projects were funded in FY 1987. During the same funding period, 27 in-house projects were conducted. Accomplishments are summarized by objectives for FY 1987.

OBJECTIVE 1:
GYPSY MOTH EFFECTS ON FORESTS

Research on the effects of gypsy moth on forests was directed at three areas: development of tree growth and mortality functions; an evaluation of silvicultural practices to prevent gypsy moth-caused mortality; and an investigation of mechanisms that affect susceptibility or vulnerability of stands to gypsy moth attack. (Cooperators: Pennsylvania State University; Virginia Polytechnic Institute and State University; West Virginia University)

* Results were published on individual tree mortality and site and tree conditions from the Central Pennsylvania Risk Rating Study (600 plots). Remeasurement on a 200-plot subset of these plots was completed in 1987. Annual levels of individual tree defoliation have proven to be significant predictors of mortality for susceptible species. Analysis of defoliation effects on diameter growth of trees between 1978 and 1985 is in process. Summaries of the hazard rating systems presently in use were published for the Gypsy Moth Annual Review, the Coping Meeting, and the Journal of Forestry.

* A study involving 475 plots in the Appalachian Plateau and Ridge and Valley Provinces has provided a vulnerability rating system. Using a stepwise procedure, species composition, slope, shade tolerance, aspect, and site index were the site and stand factors associated with defoliation-induced mortality and growth loss. Oaks were most vulnerable to mortality. The discriminant function correctly classified 75% of the trees in the model-building data set.

* Major physiographic differences in abundance values for specific species were observed between the Allegheny Mountain and Ridge and Valley regions of central Pennsylvania. Data analysis has only begun, but a definite change in species composition from oak to red maple in the Allegheny Mountains and to red maple and birches in the Ridge and Valley has occurred. Combined plant communities dominated 50% or more of the ground surface in the Allegheny Mountains region, but less than 30% of the ground surface in the Ridge and Valley region. The adequacy of regeneration stocking in these areas will be evaluated.

* Existing field tests of silvicultural treatments in Pennsylvania were remeasured and preliminary data analysis completed. Seven treated areas were established in West Virginia through the State and Private Forestry Cooperative Project. A cooperative agreement was established with the State of Ohio to select and treat 20 to 25

stands in eastern Ohio. Plans are being developed to establish more treatments in the AIPM demonstration area.

* Version 3.1 SILVAH is a decision support system to help foresters determine appropriate silvicultural prescriptions. This version is about 70% complete, and contains an installation routine for local parameters, and an editor. The program is running on an IBM-PC.

* Field work was completed for development of sampling techniques for Armillaria rhizomorphs. Data analysis is preliminary. Measurement of secondary mortality agents will be used to develop better hazard rating systems that more accurately predict forest stands that will suffer heavy mortality.

* Leaf quality of red and chestnut oaks were shown to be lower in quality (in terms of larval growth and fecundity) on susceptible sites--the opposite of predictions. A publication on stand susceptibility to gypsy moth defoliation is in press. Foliage from study sites was used to bioassay larval performance. Data has been analyzed and a second manuscript is in process. Leaves on susceptible sites appear to contribute to larval resistance to virus.

OBJECTIVE 2: BIOLOGY AND POPULATION DYNAMICS OF THE GYPSY MOTH

Research on the population dynamics and biology of the gypsy moth was focused in the following areas in 1987: sampling procedures for all stages of the gypsy moth; biological processes that influence gypsy moth populations in susceptible stands and suspected "focal" sites; meteorological parameters of the forest environment and host plants effects on gypsy moth behavior and survival. Studies were conducted at sites in Massachusetts, Vermont, New York, Connecticut, and Michigan. (Cooperators: University of Massachusetts; University of Vermont; Cary Arboretum; University of Michigan; University of Connecticut; Pennsylvania State University)

* Sampling studies proved to be a successful collaboration with various state departments of forest protection, and indicated that there are upward trends in gypsy moth densities in Massachusetts, Vermont, New York, and Connecticut. Egg mass sampling revealed low numbers during periods lacking outbreak population levels. Burlap banding of trees was associated with higher egg mass density in 1987 (Black Rock Forest, NY; Bryant Mountain, VT), as in 1984. This occurred at all elevations in New York, but only in ridgetop plots in Vermont. When larval densities were four or more larvae/tree, abundance was density-dependent. At larval densities at or less than one larva/tree, no relationship was observed between larval density and survivorship. Sampling of pre-outbreak populations in resistant and susceptible areas in Vermont will utilize plots with banded trees and plots with unbanded trees.

* Observations on biological processes in susceptible versus resistant sites include the following: 1) gypsy moth survival is greater at susceptible sites; 2) egg mass density did not differ between susceptible and resistant sites; 3) egg mass distribution was clumped in susceptible plots and was even in resistant plots; 4) no relationship was found between sites for predation by foliage gleaning birds and small mammals; and 5) mortality of instars 1-5 was density-dependent for both site types.

Susceptible sites included ridgetop locations with a high proportion of sun and lack of understory vegetation that would serve as suitable food for early instars. Resistant plots were in low elevation, mesic areas and had a high proportion of shade leaves. Because canopy closure is less in susceptible forests than in resistant and the understory of susceptible forests may be less preferred, it may be better to schedule spraying of resistant forests earlier in the season than susceptible forests.

* Two automated weather stations at Bryant Mountain, Vermont, were maintained and serviced throughout 1987. Data has been archived, along with weather data from other New England sites. The user manuals for Gypsy Moth Physical Environment Model and GM Phenology Model are complete. Fittings of regression equations of weather effects on gypsy moth defoliation in Massachusetts and Connecticut were good.

* Larval survival on 14 tree species surveyed in Michigan was observed to be greatest on witch-hazel, beech, paper birch, northern pin oak and trembling aspen. Greatest pupal survival was observed on trembling aspen; northern pin oak; and white, black, and red oaks.

In a separate study, the high phenolic content of oak leaves provided gypsy moth resistance to nuclear polyhedrosis virus (NPV). The chemical variation in leaves had little effect on larval growth, and was dependent on leaf age rather than leaf size. Data suggests that the high gypsy moth populations characteristic of susceptible forest stands are a consequence of suppression of virus disease by the high levels of tannin in the foliage.

Studies on larval feeding preferences are similarly related to leaf chemistry. Early in the season, before leaf expansion is completed, larvae feed predominantly in the lower crown. Later in the season, foliage in the upper crown is preferred. In both cases, larvae are choosing the foliage with the highest concentrations of tannin.

OBJECTIVE 3: <u>PARASITES</u> AS REGULATORS OF LOW LEVEL GYPSY MOTH POPULATIONS

Research on parasitism of the gypsy moth in 1987 sought to measure and enhance gypsy moth mortality by parasites, and evaluated the relationship between parasites and pathogens. (Cooperators: University of Massachusetts; Oregon State University; Oregon Department of Forestry)

* Parasitism of gypsy moth by Compsilura concinnata, Phobocampe disparis and Parasetigena sylvestris at sites in Caldwell Forest, Pelham, Massachusetts,proved to be density-dependent for instars 1-5. C. concinnata may be an important mortality factor for low level gypsy moth populations due to its good searching ability.

Timing of viral infections greatly affected the development of C. concinnata in gypsy moth larvae. When C. concinnata parasitized a larva early in the NPV infection, a parasite emerged 100% of the time. As the infection progressed, a smaller proportion of hosts produced a parasitoid.

Predictions of NPV-caused mortality based on counts of live and dead larvae found under burlap bands indicated a lower estimate than determined by weekly larval collections.

* Sampling studies were made comparing the accuracy of burlap, canopy, unburlapped boles, understory vegetation and ground measurements for percent parasitism of the gypsy moth. No difference in percent parasitism was detected in low density plots for the parasitoids Parasetigena sylvestris and Cotesia melanoscelus. In high density plots, burlap samples provided inconsistent measures of percentparasitism; i.e., a lower parasitism rate was detected for P. sylvestris and a higher level parasitism was measured for C. melanoscelus. K-factor analysis will be conducted on field data (1983-1987) of gypsy moth and P. sylvestris densities.

* Rogas lymantriae was released at sites in Oregon having mixed populations of gypsy moth and an alternate host, the Douglas-fir tussock moth. Sites will be observed for R. lymantriae establishment and long term control. The biology of R. lymantriae as affected by host size and species was evaluated in the laboratory.

OBJECTIVE 4: PREDATORS AS REGULATORS OF LOW LEVEL GYPSY MOTH POPULATIONS

Two approaches were used in evaluating the role of vertebrate and invertebrate predators in gypsy moth population regulation. First, predator-caused mortality was evaluated. Secondly, predators were manipulated for enhanced biological control. Predator distribution data and feeding rates/preferences will provide: 1) classification of forest susceptibility to gypsy moth outbreaks; 2) assessment of predator impact on gypsy moth mortality at different life stages; and 3) predation data for the GMLSM. (Cooperators: Southern Connecticut University; West Virginia University; University of Vermont)

* Bird densities and vegetation variables (canopy coverage and layering, shrub coverage, defoliation, tree mortality) were obtained for 42 ridgetop plots in West Virginia. Habitat models have been built for approximately 25 species of forest passerines, and will enable prediction of bird community changes concurrent with gypsy moth outbreaks.

Only seven bird species were shown to eat gypsy moth larvae consistently. (In a similar study conducted in Michigan, only the yellow-billed cuckoo ate gypsy moth in proportions greater than or equal to availability. An estimated 5% mortality of the gypsy moth population was attributed to house sparrow predation.) Because these species are either cavity nesters or ground foragers, there are management possibilities through habitat alterations.

* A 1984-1987 inventory of avian species in Vermont, New York, Massachusetts, and Connecticut detected a general decline in ground-foraging thrushes. Analysis is in process on early and late season effects of this decreased predation on gypsy moth population levels in individual plot systems.

* The effect of Dimilin on birds and other nontarget gypsy moth predators was investigated. Data analysis is in process.

* Formica obscuriventris did not feed on gypsy moth in the lab. Formica subsericia fed on instars 1-3 and occasionally pupae.

* Twenty-five different carabid species were identified from three ecological zones on Bryant Mountain, Vermont. The importance of these predators as population regulators has yet to be established.

* The level of predation by 153 migrant birds is presently being analyzed. Avian predation of egg masses in the field is also under investigation.

OBJECTIVE 5: PATHOGENS AS REGULATORS OF GYPSY MOTH POPULATIONS

The selected pathogens evaluated for gypsy moth population regulation in 1987 were gypsy moth nuclear polyhedrosis virus (LdMNPV), Bacillus thuringiensis (Bt) and microsporidia (Vairimorpha, Nosema, and Vavraia). Improvement of pathogen effectiveness was sought in research on microbial application and formulation technology. (Cooperators: University of Massachusetts; Boyce Thompson Institute; Illinois Natural History Survey and Illinois Agricultural Experiment Station; Pennsylvania State University)

* Field observations showed that prior viral contamination of oviposition sites, not rainfall, was the key component in NPV transmission. Susceptibility of outbreak larvae to environmental sources of NPV is being investigated. The smaller gypsy moth eggs which occurr in high density populations appear to produce more susceptible larvae.

Burlap sampling of larvae underestimates the occurrence of NPV mortality in the last instars. A calibration factor for improving mortality estimates is being developed. Results on horizontal transmission of NPV inoculum in soil, on bark and in silken mats were unclear due to small mammal predation of gypsy moth larvae.

* Establishment of both persistently infected gypsy moth cell cultures and colonies with LdMNPV has not yet been accomplished. Lack of cell culture infection may be due to

tissue specificity. An increased understanding of LdMNPV transmission will be provided by a physical map of the LdMNPV genome and the insertions of DNA sequences during serial passage in cell culture.

* Inoculation of "healthy" gypsy moth larvae with Autographa californica baculovirus can cause death by gypsy moth virus replication, putative induction. Similar results have been obtained using Congo red dye. Induction using Bombyx mori NPV, tobacco mosaic virus, and such stress conditions as heat, cold, and starvation have not been successful.

* Midgut larval digestive fluids did not affect infectivity of purified LdMNPV virions. Studies on the fate of LdMNPV in larval midgut epithelial cells conclusively showed that LdMNPV can replicate in midgut cells.

* Nosema and Vavraia microsporidia were released in 1986, and Vairimorpha (3 species) in 1987 by egg mass contamination. Release sites were woodlots in northern Maryland. The prevalence of microsporidian infections ranged from 10-20% in 1986 and in 1987. Moreover, Nosema persisted from 1986-87. Infected larvae indicated that horizontal transmission had occurred.

* No significant difference was found in the canopy distribution of Bt which was aerially sprayed at 29.6 BIU/ha. Spray deposit between leaves was lognormally distributed. In a study of microfeeding behavior of gypsy moth larvae on Bt-treated oak leaves, high density applications of small droplets (50-150 micrometers) were more effective than applications of larger droplets (more than 150 micrometers). LD_{95} for the three droplet size classes of 100, 200, and 300 micrometers were 10.8, 2.2, and 0.9 drops/cm, respectively. A comparative analysis is being conducted on larval feeding location as related to spray droplet distribution on the leaves. This will indicate the relative efficiency of the aerial spray technique. Deficiencies will be corrected by changing the spray system and/or altering the formulation.

OBJECTIVE 6: INTEGRATED PEST MANAGEMENT (IPM) FOR GYPSY MOTH CONTROL

Integrated pest management was evaluated for gypsy moth control using three research approaches: 1) an evaluation of IPM tactics and technology; 2) an evaluation of gypsy moth monitoring systems; and 3) the development of interactive computer models. (Cooperators: Pennsylvania State University; Cary Arboretum; University of Massachusetts; Alabama Agricultural and Mechanical University; Karen Giroux (Wilson) and Associates; University of Connecticut; Virginia Polytechnic Institute and State University)

* A prototype expert system (GYPEX) for the aerial application of insecticides for gypsy moth control was demonstrated in December 1987 at the National Gypsy Moth Review in Charleston, West Virginia. The completed modules are: early spray

decision, spray timing (which uses GMPHEN), and spray calibration. The spray date estimation module is still under development.

Working relationships have been established with other gypsy moth related projects to facilitate future incorporation of emerging knowledge into GYPEX. These contacts include Pennsylvania State University (spray pattern and calibration); USFS (spray decision, Bt efficacy, stand mortality, GMLSM, GMPHEN), and the Maryland Department of Agriculture (spray decision sampling).

* F_1 sterile eggs were released in two study sites in Vermont in 1986 and 1987. Although suppression in these plots was demonstrated, parasitism, not F_1 sterile intervention, was primarily responsible for population reduction. Suppression in leading-edge plots (Maryland's Eastern Shore and West Virginia) was not demonstrated. (However, augmentation with F_1 sterile insects significantly increased parasitism in leading-edge plots, particularly by the tachinid *Compsilura concinnata*.) In all plots (Maryland's Eastern Shore, Vermont and West Virginia) the number of F_1 sterile eggs required to achieve a 25:1 sterile:feral adult male ratio was underestimated. Possible reasons for this include underestimation of the target population and/or a F_1 sterile egg hatch which was not synchronized with the target population.

* Presentations on the use of silvicultural guidelines were made at 12 meetings and workshops, including the National SAF Meeting and the Coping with the Gypsy Moth on New Frontiers Meeting.

The West Virginia State and Private Forestry Cooperative Project has set up several new demonstration areas for field testing of silvicultural treatments.

* A pilot statewide monitoring system for prediction of gypsy moth outbreaks in Massachusetts has provided inconsistent results. A point by point comparison could not by made for racemic disparlure catches of male moths and burlap band samples of egg masses, even though an area-wide correspondence was detected.

* In comparisons of standard pheromone trap catches with low-release-rate traps, numbers of males captured were not significantly different. The release rate reduction was only 3-5 fold, and it appears likely that a 100 fold rate reduction may be necessary to observe changes in the number of males captured. Behavioral observations at individual pheromone traps revealed a deterrent effect by high concentrations of (+)-disparlure at close range. This explains, in part, why reductions in release rate produced little or no changes in the number of males captured.

Comparison of standard pheromone trap catches with racemic-baited traps and cylinder traps showed a 3 fold and 100 fold male catch reduction, respectively.

* A four year study conducted in Massachusetts, Vermont and Maryland simultaneously measured the number of males captured in 16 pheromone traps and the number of pupae and egg masses under approximately 300 burlap bands and the number of egg masses on 37 prism point plots. Preliminary analysis indicates that populations which are newly established (i.e., most populations in Virginia and Maryland) show a significant correlation between egg mass densities and moths per trap. Populations which have been established for a long time or are in an outbreak phase (i.e., Massachusetts and some in Virginia) do not show a strong correlation.

Additional analyses were made to determine if there is a relationship between population stress, adult size, fecundity, and egg mass density--using male wing length as an egg mass density estimator. Data from Maryland and Virginia provided a good correlation between male wing length and eggs per mass, and wing length and egg masses per unit area at the plot level for 1985 and 1986 data. To further validate this relationship, approximately 200 sites throughout Maine, Massachusetts, Connecticut, Vermont, Maryland, and Virginia were trapped and egg mass estimates obtained during the 1987 field season. Pheromone trap catch models are being developed, and use a sequential approach.

* A version of the Stand Submodel - that portion of the GMLSM that predicts tree growth and mortality - has been made into a stand-alone model known as the Damage Model. The initial version of a menu-driven package for this model is designed to allow operators with little computer experience to set initial conditions, select options, and run the model. These same enhancements will be applied to the entire GMLSM in 1988.

* The Gypsy Moth Submodel that uses daily weather to simulate the phenology of both gypsy moth and its hosts has also been made available as a stand-alone model known as GMPHEN -- the Gypsy Moth Phenology Model.

* Major restructuring of the Predator and Parasite Submodel (PANDP) of the GMLSM to take advantage of the increased sophistication of the gypsy moth developmental algorithm has been accomplished, and has been successfully merged with the complete GMLSM. The influence of weather parameters on overall model behavior and specific effects on PANDP need to be examined.

* The GMLSM and accompanying manuscripts that document the model are currently being revised to incorporate suggestions made during two GMLSM workshops (Feb. 1987, Oct. 1987). During the past year, an IBM-PC compatible version of the GMLSM was developed using the Microsoft Fortran-77 package. Version 1.0 of the GMLSM will be released for testing by users in late spring of 1988 for both IBM-PC compatible microcomputers and Data General minicomputers.

OBJECTIVE 7: TECHNICAL SUPPORT FOR GYPSY MOTH RESEARCH

Technical support efforts for the gypsy moth program were primarily concerned with two facets of rearing technology. First, rearing technology studies for gypsy moth sought to ensure a continuous supply of insects of consistent quality to researchers. This involved: developing genetic markers for a gypsy moth strain; devising a diet for larvae previously fed on foliage in the field; and improving sex ratio manipulation, pupal harvesting and quality control of lab-reared insects. The second facet of rearing technology involved field trials of sterile males and sterile eggs. (Cooperators: University of Massachusetts; APHIS)

* F_1 sterile establishment and development on five tree species was compared with wild and standard laboratory reared (NJSS-FS) gypsy moth. Establishment and survival to 2nd instar by F_1 sterile neonates was 50% less than establishment/survival for wild and lab-reared neonates on all plant species. Development of F_1 sterile insects was 2-3 days slower. Approximately 40% of F_1 sterile male pupae were synchronized with wild pupae.

Development and survival of F_1 sterile larvae may be explained in part by larval behavioral differences and host preferences. On witch hazel, 40-59% of the wild larvae were found on leaves, compared to 75-78% of NJSS and F1S larvae. Only 8-25% of the wild larvae were found on red maple leaves compared to 50-73% of NJSS and F_1 sterile larvae. Tests to confirm differences in location will be made on small uncaged trees in the spring of 1988. There were no apparent differences in activity; the majority of all strains were resting.

* In 1987, 17,200 high quality gypsy moths (disease-free and developmentally predictable) were supplied to Cooperators.

* In a study on mating propensity, F_1 sterile males averaged 1.8 matings per day compared to 3.4 for wild, 3.5 for lab-reared and 3.3 for 10K males. All feral males that mated at least once mated a second time; whereas only 50% of the F_1 steriles mated a second time. Overflooding ratios will need to be doubled to compensate for this mating deficiency.

* "Straggling" and "non-straggling" families were established, and the variation in development of each family was quantified. Straggling families were detected within 4 days after infestation. Development and survival were monitored by families. Production of male and female pupae was reduced 26 and 31%, respectively. An extensive survey of microbials which might be associated with straggling was conducted, with negative results.

* Laboratory studies revealed that sterilized neonates are less active and survive a shorter period without food. There was no indication that these impairments are an attribute of the genotype of the strain of gypsy moth irradiated rather than an effect of radiation damage.

PUBLICATIONS

J. V. Maddox/M. R. Jeffords, P.I. 1987. Microsporidian spores in gypsy moth silk: A possible route of horizontal transmission. J. Invertebr. Pathol. 49: 332-333.

D. R. Miller, P.I. 1987. A numerical simulation of the microclimate of gypsy moth caterpillars in forest canopies. by D. E. Anderson, D. R. Miller, W. E. Wallner, T. L. Taigen, J. Schwartz. Proceedings 8th Conference Aero and Bio-Meteor. of the A.M.S., Purdue Univ., W. Lafayette, Ind., Sept. 14-18, pp. 353-355.

1987. A study of the effects of weather factors on gypsy moth defoliations in MA and CT. by T. Mo and D. R. Miller. USDA, For. Service Supplemental Report. June.

1987. Description and development of a numerical model simulating the forest environment and body temperatures of gypsy moth caterpillars. by D. E. Anderson and D. R. Miller. Report to USDA, Forest Service, Broomall, PA.

K. A. Sheehan, P.I. 1984. Development of forest-gypsy moth models. In: Proceedings, 1984 National Gypsy Moth Review; November 26-29, 1984. Charleston, WV: pp. 99-102.

R. C. Whitmore, P.I. 1987. Estimating defoliation using stratified point-intercept sampling. by R.J. Cooper, K. M. Dodge, and R. C. Whitmore. For. Sci. 33:157-163.

1987. Gypsy moth impacts on nongame bird populations, pp. 48-58. In: Coping with the Gypsy Moth in the New Frontier. (eds.) S. Fosbroke and R.R. Hicks. WV Univ. Books, Morgantown, WV.

1987. Environmental fate of Dimilin 25-W in a central Appalachian forest. by P. J. Martinat, V. Christman, R. J. Cooper, K. M. Dodge, R. C. Whitmore, G. Booth and G. Seidel. Bull. Environ. Contam. Toxicol. 39: 142-149.

PUBLICATIONS (In Press)

M. R. Jeffords/J. V.Maddox,P.I. Egg contamination as a method for the inoculative release of exotic microsporidia of the gypsy moth. by M. R. Jeffords, J. V. Maddox, M. L. McManus, R. E. Webb and A. Wieber. J. Invertebr. Pathol.

J. C. Schultz, P.I. Variation in leaf quality of two oak species: Implications for stand susceptibility to gypsy moth defoliation.

K. A. Sheehan, P.I. 1985. Gypsy moths and Northeastern Forests: Modeling a complex biological system. In: Proceedings, 1985 Symposium on System Analysis in Forest Resources; Dec. 9-12, Athens, GA.

W. E. Wallner, P.I. Estimating densities of late-instar gypsy moth, Lymantria dispar L. J. Econ. Entomol.

R. Whitmore, P.I. 1988. Effect of Dimilin application on eastern deciduous forest birds. J. Wildl. Manage. by R. J. Cooper, K. M. Dodge, S. Donahoe, P. J. Martinat and R. C. Whitmore.

1988. Level of prey identification and dietary overlap among insectivorous birds. by R. J. Cooper, P. J. Martinat, and R. C. Whitmore. In: Food Exploitation by Terrestrial Birds: Studies in Avian Biology. (eds.) M. L. Morrison, C. J. Ralph and J. Verner.

1988. Effect of Dimilin 25-W on the canopy arthropod community in a central Appalchian forest. by P.J. Martinat, C. C. Coffman, K. M. Dodge, R. J. Cooper and R. C. Whitmore. J. Econ. Entomol.

1988. Insect sampling methods in ornitholog. by R. J. Cooper and R. C. Whitmore. In: Food Exploitation by Terrestrial Birds: Studies in Avian Biology. (eds.) M. L. Morrison, C. J. Ralph and J. Verner.

1988. Sampling forest canopy insects using direct observations, by R. J. Cooper. In: Estimation and Analysis of Insect Populations. Springer-Verlag Studies in Biostatistics. (eds) L. L. McDonald, J. A. Lockwood and J. A. Logan.

W. G. Yendol, P.I. 1988. Evaluation of the influence of droplet size and density of Bacillus thuringiensis against the gypsy moth larvae. by J. E. Bryant and W. G. Yendol. J. Econ. Entomol.

1988. Distribution of deposit in an oak canopy following aerial application of Bacillus thuringiensis. by J. E. Bryant, W. G. Yendol and M. L. McManus. Proceedings of Symposium on the Aerial Application of Pesticides in Forestry, Oct. 1987, Ottawa, Canada.

1988. Penetration of oak canopies by a commercial preparation of Bacillus thuringiensis by air. J. Econ. Entomol. (In review)

NORTHEASTERN FOREST EXPERIMENT STATION
FUNDED PROJECTS
FISCAL YEAR 1987 GYPSY MOTH COOPERATIVE PROJECTS

Principal Investigator	Institution	Obj.	Project Title
Todd Bowersox	School For. Resources PA State University University Park, PA 16802 (814)865-4841	1	Regeneration potential in stands with heavy gypsy moth caused mortality
Joe S. Elkinton	Dept. of Entomology University of Mass. Amherst, MA 01003 (413)545-2283	2	Manipulation of GM density and its impact on mortality
Joe S. Elkinton	University of Mass. Amherst, MA	3	Interaction of parasitoids with other natural enemies as regulating agents in gypsy moth populations
Joe S. Elkinton	University of Mass. Amherst, MA	5	Nuclear polyhedrosis virus dynamics in gypsy moth populations
Joe S. Elkinton	University of Mass. Amherst, MA	6	Development of a gypsy moth moth population monitoring system
Robert R. Granados	Boyce Thompson Inst. Cornell University Tower Road Ithaca, NY 14853 (607)257-2030	5	Virulence of *Lymantria dispar* baculovirus: Effect of larval digestive fluids and peritrophic membrane on virus pathogenicity
Ray R. Hicks	Division of Forestry W.Virginia University Morgantown, WV 26506 (304)293-2941	1	Determining mortality functions for gypsy moth-defoliated stands in the Appalachian Plateau and Ridge and Valley Provinces
Clive Jones	Inst. Ecosystem Studies NY Botanical Garden Mary Flagler Cary Arboretum, Box AB Millbrook, NY 12545 (914)677-5343	2	Habitat-differentiated gypsy moth population dynamics at low densities

Principal Investigator	Institution	Obj.	Project Title
Dave Leonard	Dept. of Entomology Fermald Hall University of Mass. Amherst, MA 01003	2 7	Determine the quality or fitness of the F_1-sterile gypsy moth larva relative to establishment, development and survival when compared to feral target population
Joe Maddox/ Michael Jeffords	Illinois Natural History Survey 607 East Peabody Champaign, IL 61820 (217)333-7090	5	The use of microsporidia for population management of the gypsy moth
David A. Marquis/ Richard L. Ernst	NEFES Forestry Sciences Lab. PO Box 928 Warren, PA 16365 (814)563-7587	1 6	Major enhancements of SILVAH to Microcomputers and Data General (Phase I)
David R. Miller	Dept. of Renewable Resources, Univ. Conn. Storrs, CT 06268 (203)456-2839	2 7	Development of a model to simulate the forest habitat of the gypsy moth
Bruce L. Parker	Dept. of Plant & Soil Science, Univ. Vermont Burlington, VT 05401 (802)658-4453	2 4	Biological processes influencing gypsy moth populations in susceptible and resistant forests
B. Pinker	Dept. of Plant & Soil Science, AL Agric. & Mech. University Normal, AL 35762 (205)859-7272	6	Enhanced user-friendly computer package for the Gypsy Moth Life System
C. W. Pitts	Dept. of Entomology PA State University University Park, PA 16802 (814)865-1895	6	Quantification of gypsy moth pheromone catches
Nobel S. Proctor	Biology Dept. Southern Conn.State Univ. New Haven, CT 06515 (203)481-9195	4	Role of avian predators in gypsy moth dynamics and and management
F. W. Ravlin	Dept. of Entomology VPI & SU Blacksburg, VA 24061 (703)961-6826	6	Development of a gypsy moth population monitoring system

Principal Investigator	Institution	Obj.	Project Title
Michael Saunders	Dept. of Entomology PA State University University Park, PA 16802 (814)863-2979	6	Development of an expert system prototype for the aerial application of insecticides for gypsy moth suppression
J. C. Schultz	Pesticide Res.Laboratory Dept. of Entomology PA State University Univ. Park, PA 16802 (814)863-4438	1 2	Leaf quality of two oak species in gypsy moth-resistant and -susceptible stands
Chuck Schwalbe/ Vic Mastro	USDA, APHIS Otis Methods Dev. Center Bldg. 1398, Otis Air Base MA 02542 (617)563-9303	7	Stockpile eggs for sterile male F_1 sterile behavior
John Scrivani	Dept. of Forestry VPI & SU Blacksburg, VA 24061 (703)961-7682	1	Determining growth impacts of defoliation by gypsy moth
Robert C. Whitmore	Division of Forestry WV University Morgantown, WV 26506-6125 (304)293-4797	4	Vertebrate predator and gypsy moth population interactions and their influence on defoliation
Karen Giroux (Wilson)	Karen G. Wilson & Assoc. Route 2, Box 84A Apex, NC 27502 (919)733-6930	6	Revision and testing of the parasite and predator submodel of the (GMLSM) Gypsy Moth Life System Model
John Witter	Dept. of Natural Res. University of Michigan Ann Arbor, MI 48109-1115 (313)764-2249	1 2	Forest site factors and gypsy moth growth and reproduction
H. Alan Wood	Boyce Thompson Institute Cornell University Tower Road Ithaca, NY 14853 (607)257-2030	5	Persistent gypsy moth nuclear polyhedrosis virus infections
W. G. Yendol	Dept. of Entomology College of Agric. PA State University Univ. Park, 16802 (814)863-4432	5	A continued study on the spray distribution, size, volume, effectiveness, and longevity and other characteristics of commercial bacterial insecticides impinging on oak forest canopies, 1987-1988

NORTHEASTERN FOREST EXPERIMENT STATION
IN-HOUSE PROJECTS
FISCAL YEAR 1987 GYPSY MOTH COOPERATIVE PROJECTS

Principal Investigator	Institution	Obj.	Project Title
Normand Dubois	NEFES Center for Biological Control of NE Forest Insects & Diseases 51 Mill Pond Road Hamden, CT 06514 (203)773-2026	5	Efficacy of ground application of NRD-12 at 7.5 BIU/A and at 15 BIU/A against second and fourth instar gypsy moth
Normand Dubois	NEFES Hamden, CT	5	Evaluation of the field effectiveness of NRD-12, a new strain of Bacillus thuringiensis, against the gypsy moth
Kurt Gottschalk	NEFES USDA, FS 180 Canfield St. PO Box 4360 Morgantown, WV 26505	1 6	Testing and evaluation of silviculture guidelines for gypsy moth
Kurt Gottschalk	NEFES USDA, FS Morgantown, WV (304)291-4613	1 6	Expansion of SILVAH to include gypsy moth prescriptions
Kurt Gottschalk	NEFES USDA, FS Morgantown, WV	1	Stem analysis of thinned and and unthinned defoliated trees
Kurt Gottschalk	NEFES USDA, FS Morgantown, WV	1	Effects of previous stand management on tree mortality following gypsy moth defoliation
Kurt Gottschalk	NEFES USDA, FS Morgantown, WV	1 6	Effects of silvicultural treatments on growth, mortality and regeneration in gypsy moth defoliated mixed-oak hardwood stands
David Marquis/ Richard Ernst	NEFES Forestry Sciences Laboratory PO Box 928 Warren, PA 16365 (814)563-7687	1 6	Major enhancements to SILVLAH and conversion of SILVAH to microcomputers and Data General (Phase I)

Principal Investigator	Institution	Obj.	Project Title
Michael Montgomery	NEFES Center for Biological Control of NE Forest Insect & Diseases 51 Mill Pond Road Hamden, CT 06514 (203)773-2025	2	Quantitative aspects of food utilization by the gypsy moth *Lymantria dispar*
Michael Montgomery	NEFES Hamden, CT	7	Comparisions of development physiology of different populations of gypsy moth
Carol Butt-ODell	NEFES Hamden, CT (203)773-2374	7	Supply high quality insects in research quantities to cooperators
Tom ODell	NEFES Hamden, CT (203)773-2024	7	The etiology of struggling, or delayed development, in in laboratory populations of gypsy moth which is significantly reducing production of F_1-sterile males
Tom ODell	NEFES Hamden, CT	7	Feasibility of applying F_1-sterile eggs in the fall prior to hatch of target population
Tom ODell	NEFES Hamden, CT	6	Determine the effect of sterile egg release on the trend of sparse and moderate gypsy moth populations
Tom ODell	NEFES Hamden, CT	6 7	Mating propensity as a measure of competitiveness or fitness of gypsy moth males
Tom ODell	NEFES Hamden, CT	7	Genetic markers for identifying gypsy moth populations
Tom ODell	NEFES Hamden, CT	6	An IPM approach for utilizing the F_1-sterile gypsy moth technique: Combining genetic manipulation and parasite enhancement to effect pest population regulation
John Podgwaite	NEFES Hamden, CT (203)773-2033	5	Aerial test of a Gypchek-Orzan formulation against gypsy moth populations in MD

Principal Investigator	Institution	Obj.	Project Title
John Podgwaite	NEFES Hamden, CT	5	Efficacy of sequential ground application of a Gypchek-Orzan formulation against low and moderate density gypsy moth larval populations in MD
Katharine Sheehan	NEFES USDA, FS Morgantown, WV (304)291-4613	2 6	Phenology of budbreak and gypsy development
Katharine Sheehan	NEFES Morgantown, WV	6	Updating and evaluating the Gypsy Moth Life System Model
Harvey Smith	NEFES Hamden, CT (203)773-2023	4	Determining the relationship between forest susceptibility to defoliation by gypsy moth and the diversity, density and impact potential of the predator community
(Vacant)	NEFES USDA, FS Morgantown, WV (304)291-4613	1 6	Central Pennsylvania Gypsy Moth Moth Risk Rating/Impact Plat Network
William Wallner/ Phyllis Grinberg	NEFES Hamden, CT (203)773-2022	2 6	Sampling late instar gypsy moth at low population densities
William Wallner/ Phyllis Grinberg	NEFES Hamden, CT	3 7	Laboratory and field evaluation of _Rogas lymantriae_, an exotic endo parasite of gypsy moth
William Wallner	NEFES Hamden, CT	4	The importance of ants (_Formica subsericia_ and _F. obscuriventris_ as predators of gypsy moth life stages
Phil Wargo/ Ray Hicks	NEFES USDA, FS Hamden, CT (203)773-2030	1	Abundance and distribution of _Armillaria mellea_ rhizomorphs in defoliated and non-defoliated hardwood stands

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
370 REED ROAD
BROOMALL, PA 19008

NATIONAL AGRICULTURAL LIBRARY
1023191041

U.S. OFFICIAL MAIL
BROOMALL
APR 14 '88
PA.
PENALTY FOR PRIVATE USE $300
U.S. POSTAGE
= 0.45
METER
504105

Intermountain Research Station
Library
324 25th Street
Ogden, UT 84401